An Experiment To Determine The Number of Repetitions

Necessary to Memorize and Retain

With Maximum Certainty

A Miscellaneous Collection of Facts

BY

A. E. WAGNER, Ph. D.

Nesquehoning, Pa.
MAY 1910

The Number of Repetitions Necessary to Memorize
And Retain With Maximum Certainty
A Miscellaneous Collection of Facts

INTRODUCTION

The Jesuit Schools for more than a century were the unrivaled leaders in the educational world. Their aim was to prepare for leadership in the evangelization of humanity. Their entire system was based upon the principle that it is better to teach a relatively small amount in a thorough manner, than to give an indefinite impression of a much larger quantity. They gave frequent reviews. Each day began with a review of the things taught on the previous day; each week ended with a review of the things presented during this time; each year was closed with a review of the work done that year; and the whole course was then reviewed by teaching it. The entire system had as one of its leading characteristics frequency of repetition accompanied by prelection and erudition. They succeeded in securing intellectual development and the results desired were always certain.

After the Jesuits, Ratick was the first to realize that educational method must secure maximum certainty of recall, and that this is obtained best by repetition. One thing at a time and that often repeated was one of his maxims. He had the sagacity to foresee that successful mastery necessitated a relatively small content, though he failed to construe "one thing" as a basal element in thinking, a point or unit of subject matter, and often repeated and re-repeated his "one thing" until some things were repeated to death. He was not sagacious enough, however, to perceive the wisdom of using the children of his school to determine the conditions under which repetition will most advantageously secure maximum certainty of recall.

The next attempt that was made along the lines of repetition to secure mastery was made by Professor Cornman of Columbia in connection with the spelling. In the investigation hereinafter described, an attempt is made to secure information along the same lines.

Practical pedagogy makes it necessary that we know more definitely how to secure the excellences of the method of repetition used by the Jesuits and Ratick and how to avoid its defects. This knowledge can not be gleaned by the application of theoretical psychology but must be derived from facts scientifically determined.

That scientific methods should be used in procuring pedagogical knowledge or in deriving facts upon which principles may be formulated, may seem strange, but it is in no way more unusual than the use of the same methods in any other field of human endeavor. The good teaching which we have will be improved as soon as principles based upon facts scientifically determined are applied in the practical work of the school room. Valuable indeed to any teacher will it be to know the number of repetitions needed by children, under ordinary circumstances, to learn things, and equally valuable will it be to know how frequent the repetitions must be in order that the facts may be retained when once they are learned.

In the experiments of which a description follows, an attempt was made to determine:

1. How many repetitions are necessary to secure the mastery of facts with maximum certainty; and

2. At what intervals the repetitions must occur in order that the mastery, when once secured, may be retained.

———◆◆———

THE FIRST EXPERIMENT.

When the experiment was first begun, it seemed reasonably certain to the experimenter that the written form of repetition would be the most desirable. Questions, the answer to which could be given in a single sentence, or even a single word, were selected and given in order to avoid the element of judgment in determining the relative worth of the answers, and in order to insure, with maximum certainty, that the answers given would be either entirely correct or incorrect. Instead, however, of giving the single word desired as the answer to the question, a number of the children substituted other terms from which it was impossible to determine whether they retained the major portion of the original presentation; or whether, as the word used in answering often indicated, they retained but a small portion of the content of the word desired for an answer which the original presentation was intended to give. In a number of instances, the words which were used in answering the question may have or may not have signified that the original presentation was retained. In writing the names of two rivers of Africa as the "Murray of Darling" instead of the Murray and Darling, unless one is willing to assume that the placing of the "of" instead of the "and" was a mere slip of the pencil, the conclusion that much of the original presentation was no longer functioning is inevitable. A similar illustration occurred with the words "llanos," "lepidodendron," "Locust Mt." and others. Were I to try the experiment again, other forms of writing the answer than writing merely one word would be used.

The presentation of the facts in each case was as clear and as full as the presenter could make it. All forms of presentation were used that could be thought of. The facts to be remembered were illustrated by pictures, stories, and drawings. Every form of apperceptional contribution known to be available was utilized.

Some of the repetitions were called for by the teacher, others by the experimenter. That the number of errors is as small as it is, may be due to the fact that the desire on the part of the teacher to have her room make a good showing was stronger than her desire to have the experiment scientifically accurate.

Only such facts were presented as seemed to be unknown to the children with whom the experiment was tried. Some of these were selected because of their local significance, and because it was somewhat difficult to find facts with which children of an entire group who had completed an elementary geography and history were unfamiliar. This is especially true of the facts that were used with the seventh and eighth grades.

All facts were presented at one sitting by myself. This required three-fourths of an hour for the fifth, sixth, and

eighth grade, and one and one-fourth hours for the seventh grade. When the fact had been presented by the experimenter, the answer desired for future repetitions was written upon the blackboard by himself, and upon a slip of paper by the children. When all the facts had been presented these papers were collected. At each repetition the questions were asked by the experimenter or the teacher, and the answers were written upon slips of paper by the children in the same manner as spelling words are usually written. The errors were then marked by the children, each retaining his or her own slip, the experimenter or the teacher repeating the correct answers in their numerical order. Each child making an error was required to write the correct answer at the close of the exercise. Before the papers containing the children's answers were filed and before the exercise was over all papers were looked over by the experimenter or the teacher to avoid having mistakes pass unnoticed. The number of repetitions as indicated on the sheets containing the results means the number of times that they were written on paper, except in the eighth grade where they were repeated orally.

The papers containing the results of the first repetitions showed a lamentable lack on the part of the slow learners to get the correct spelling of the terms required in the answers. No attempt was made to secure correct spelling by having a repetition of the fact. In giving the correct answer while the errors were being marked the teacher or the experimenter spelled the word instead of saying it. It is possible that this form of oral repetition aided in impressing the fact to be remembered as well as the spelling of the word that stood for it. It was necessary to spell the answers five times with the sixth grade folks in order to secure maximum correctness of spelling, while with the seventh it required but three, and with the fifth two.

The questions which were given to the fifth grade with the answers that were desired follow:

1. What important geographical circle crosses South America near the mouth of the Amazon River? The Equator.
2. What important geographical circle crosses South America near the location of the city of Rio Janeiro? The Tropic of Capricorn.
3. What season do they now have a t Buenos Ayres? Autumn.
4. What ocean borders the eastern side of South America? The Atlantic.
5. What island at the southern extremity of South America? Terra del Fuego.
6. What cape at the southern extremity of this island? Cape Horn.
7. What is the largest river of South America? Amazon.

8. What strait between Terra del Fuego and South America? Strait of Magellan.

9. What is the island at the mouth of the Orinoco River and for what is it noted? Trinidad, noted for pitch.

10. What mountains along the western coast of South America? Andes.

11. How are the summits during the entire year? Snow covered.

12. What three important minerals are found in these mountains? Gold, silver and copper.

13. What three animals inhabit the Andes regions? Condor, llama and alpaca.

14. Name two highland regions of South America. Andes and Brazilian.

15. Where is the rainiest region of the world? Along the Amazon.

16. Name three valuable trees that grow in South America. Mahogany, rosewood and india-rubber.

17. What is the name given to the plains along the Orinoco River? Llanos.

18. What two seasons do they have in Venezuela? The Rainy and the Dry.

19. What name is given to the plains along the Amazon? Silvas.

20. About how many miles from the most northern to the most southern point of South America? About 1500.

A glance at the questions will show that they all refer to South America and that there is nothing like a logical order in their arrangement. The answers desired to three of them require three words, similar in the sense that three of these are mineral products, three are the names of animals, and the three remaining ones the names of trees. The effect of this association will be noted in the results.

The questions with the answers that were desired which follow are the ones that were given to the sixth grade:

1. About how large is Australia? About as large as the United States, about 3 1-2 million square miles.

2. How is the interior portion of the Australian continent with respect to heat and moisture? It is a desert.

3. What valuable mineral is extensively mined in Australia? Gold.

4. What is the leading occupation in New South Wales? Stock raising.

5. Sydney has an extensive trade with what city in the United States? San Francisco.

6. To what race do the native tribes belong? Hamitic or Black Race.

7. Name three important trees of Australia. Bread-fruit, cocoa-palm and banana.

8. What is exported from South Australia? Wool, **grain** and copper.
9. What is the religion of the native tribes? Cannibalism.
10. Name two of the most noted cities. Melbourne and Sydney.
11. How are the Australian colonies united? Into the commonwealth of Australia.
12. About what is the latitude of Melbourne? About 40 degrees South latitude.
13. What three valuable fruit trees grow in Australia? Banana, bread-fruit and cocoa-palm.
14. By what kind of people was Australia colonized? English convicts.
15. When was the Australian Commonwealth established? Jan. 1, 1901.
16. What are the two most important rivers of Australia? Murray and Darling.
17. How far from Australia are the Fiji Islands? 1200 miles east.
18. What island near the southern coast of Australia is covered with dense forests? Tasmania.
19. In what city of Australia did the lady live who recently visited our school? Ballarat.
20. What is the principal animal native to Australia? The kangaroo.

The questions that were used with the seventh grade were those that follow:

1. About what is the area of Mauch Chunk Township? Twenty square miles.
2. At the base of what mountain is this school building? Sharp.
3. What mountain on the opposite side of Panther Creek Valley? Locust.
4. How high above the sea level is the Lehigh River at Lehigh Gap. 389 feet.
5. About how high above the sea level is Mt. Pisgah? 1340 feet.
6. What is the meaning of Nesquehoning? Narrow Valley.
7. At what place was Carbon County first settled? At Gnaden Hutten.
8. Write the name of the religious sect and the leader of those who made the first settlement. Moravians, Zinzendorf.
9. Indians from what two tribes did the Moravians try to convert to Christianity? Delawares and Mohicans.
10. What was the name of the family that the Indians carried into captivity? Gilbert Family.
11. What relic of this captivity is still to be seen in Mauch Chunk? A Moccasin.

12. Where was the first white man's home built in Mauch Chunk Township? Lausanne.

13. The boyhood of what famous artist was spent at this place? Rothermel.

14. To what man of Washington's army did Lydia Darrh give the information that the British generals had planned an attack on the Americans in her house? Colonel Craig of Carbon County.

15. Who is the most influential man connected with the history of Carbon County? Asa Packer.

16. What important rock strata have their outcrop at Mauch Chunk? Mauch Chunk Red Shale.

17. What layer of rock strata forms the top and the bottom of the coal measures? Pottsville Conglomerate.

18. What is the thickness of the coal measures? 1855 feet.

19. What is the name of the plant that formed the larger part of these coal strata? Lepidodendron.

20. What is coal? Locked up sunlight.

It will be observed that the questions for this group are questions that deal with facts that have only local value, and that all of them were extremely valuable and significant to the group of children to whom they were given. Not one of the group had previously had any idea as to the area of the township in which they lived. Questions 1 and 2 referred to the two mountains which enclosed the valley in which the children lived. The names presented are those that were applied by the Pennsylvania Geological Survey. A number of the children of the group had names for these mountains that they had gotten by tradition but the names were as various as they were numerous. The effect of this learning another name for the same thing was not noted as carefully as it should have been, but the answers to these two questions at least were not different enough from the others to make them especially noticeable.

Not any of the children had any idea of the height of the mountains in the midst of which they lived. In the presentation of questions 4 and 5 the height of a number of the mountains in the county was told to the children but only the highest and the lowest point was required. The remembering of these numbers presented no unusual difficulty, and the time of forgetting was too short to really determine, though it is possible that the names would stick longer than the figures.

Questions 7 and 10 refer to Indian massacres and raids that were made on the inhabitants of the region after the defeat of Braddock. The stories of these massacres with their ethical significance was given during their presentation. The same is true of 8, 9 and 11.

The story referred to in 14 was new to nearly all of the children, and Colonel Craig's connection with it they had never

known, though a number of them knew many of the Craig descendants.

With number 15 was presented the navigation of the Lehigh, the building of the Lehigh Valley Railroad and the founding of Lehigh University.

The geological strata referred to in the remaining questions were explained and illustrated by drawings and examples, and attention was called to a collection of strata near the school building where the rocks which were once flat have been tilted into an almost vertical position and attain to an altitude of over 1400 feet. This illustrating and explaining was especially true of questions 19 and 20.

The questions used with the eighth grade were given about the time the group was having its final review in geography. It was, therefore, somewhat difficult to select geographical questions with which the entire group was entirely unfamiliar. The questions that follow are the ones that were used:

1. What is proved by the shadow which the earth casts on the moon? That the earth is round.
2. Name the three planets nearest the earth. Mercury, Venus, Mars.
3. What keeps bodies on the surface of the earth? Gravity.
4. What changes are caused by the revolution of the earth around the sun? Change of seasons.
5. What instrument do mariners use to determine direction? Compass.
6. Latitude is measured on what lines? Meridians.
7. The great highlands of the continents form a great horse-shoe from where to where? Cape Horn to Good Hope.
8. Which planet has four moons? Jupiter.
9. Which planet has the rings? Saturn.
10. How have mountains been formed? By the folding of the rock layer.
11. What term is applied to the wearing away of the land? Erosion.
12. Give the most noted example of erosion in Carbon County. Lehigh Gap.
13. What is the inclination of the earth's axis? 23 1-2 degrees.
14. If the earth inclined 33 1-2 degrees what would the width of the temperate zone be? 23 degrees.
15. What is the name of the path in which the earth travels around the sun? Orbit.
16. The Frigid Zone is cold because the sun's rays fall how? Slanting.
17. What is wind and how caused? Air in motion caused by its unequal heating.

18. What usually causes deserts? Mountains or lack of them.
19. Give the scientific name for the black race. Ethiopian.
20. What prevents the possibility of boiling eggs on the summits of the highest mountains? Atmospheric pressure.
21. What barrier causes the fauna of Australia to differ from the rest of the world? The ocean.

With the eighth grade each repetition was conducted orally during the various parts of the day indicated. This would give the individuals that were not reciting an opportunity to hear 17 repetitions; since, however, individuals were called upon at irregular periods of the day such as suited the convenience of the teacher or pupil, it is probable the attention of each pupil was concentrated on some personal and individual task, and that not nearly seventeen repetitions were heard by any one pupil.

In conducting this experiment such disposal of the difficulties that presented themselves was made as the exigencies of the case seemed to warrant. The results are reliable only to the extent of being reasonably approximate. Among the factors which prevented the experiment from being scientifically accurate are the following:

1. The number of individuals with whom the experiment was tried was too small. The experiment should be tried with a large number of pupils, several thousand.

2. The number of slow learners varied in several of the groups and would proportionately modify the showing of the group.

3. The period during which the experiment was conducted was entirely too short to conclude that the facts presented and repeated were fixed with maximum certainty of permanent recall. It took but a very short time until the facts were fixed, but the term's close was too near to allow the interval between the various repetitions to be constantly increased.

4. The number of repetitions was modified by some of the children using them after the fourth repetition in their playing school. The brighter children of the fifth grade could repeat the questions and answers after the fourth repetition, and used them in the hall as lesson for their play school. Individuals of the other grades also were observed to ask the questions at random of each other.

5. The facts should always be presented by the same individual so there could be associated with each individual fact the same bits of interesting detail that would make all the facts equally well remembered by each group of children and each fact equally as fully apperceived.

6. The desire and anxiety on the part of some of the

teachers whose children were experimented upon to have the results appear well may have caused them to give hints during the repetitions that slightly modified the results.

7. In several cases the word required for the answer was correctly retained, but the content which the presenter had hoped to connect with it permanently could not be even reproduced in part, and was probably entirely forgotten.

8. Answers were received that were substitutes for the ones required, and from these answers it was impossible to determine whether the child had the presentation that was given, or whether apperception had made such contributions and association had caused such related ideas to function that the content in the learner's mind no longer corresponded to that at the close of the original presentation.

In an examinaion of the fifth and sixth year folks that was given at the end of the school year, in answer to the general question, "Tell all you can of South America," "of Australia;" each individual included in his answer some of the facts that were presented in the experiment. One individual, a fifth grade pupil, included eighty-one per cent., and no individual had less than twenty per cent.

The question relating to the formation of the Australian Federation, the date 1908 was substituted for the one required by two individuals on three different repetitions.

In the case of questions that were so framed as to require two or more words for an answer, during the earlier repetitions, it happened that only part of the required answer was recallable; this same thing did not occur during the later repetitions, due possibly to the fact that the associations between the various parts of the answer became more permanent as the result of the oral repetitions of the errors that were made during the written repetition.

By an examination of the sheets containing the results it will be seen that the fifth grade folks practically knew the twenty questions at the end of the fourth repetition, the sixth year folks by the end of the fifth repetition, the seventh year folks by the end of the fourth repetition, and the eighth year folks by the end of the third repetition. Averaging these approximations the statement might be made that the twenty facts were learned with four repetitions.

That the outcome of the experiment should be as it is, surprises no one more than myself. Though these results lack absolute exactness, they are sufficiently exact to give us the information necessary to direct intelligently our future educational method, and aid us in the intelligent selection of our education content. It is accurate in a sufficient degree to indicate to us the kind of method that should be used to fix essential content. The essential feature of this method must be, not several repetitions in a short period of time;

but a relatively small number of repetitions with a constantly increasing interval of time between the repetitions that continue through rather a long period.

In the results which follow, the numbers along the left hand side of the column of figures indicate the number of pupils. Absences are indicated with a cross. The numbers below the repetitions, as indicated at the top of the columns, denote the number of errors that were made by the various individuals. The date at the top of each column means that the repetition was conducted upon that day.

Results with Fifth Grade

Pupil's No.	First Rep. Mar. 4	Sec. Rep. Mar. 5	Third Rep. Mar. 12	Fourth Rep. Mar. 26	Fifth Rep. Apr. 3	Sixth Rep. Apr. 7	Sev. Rep. Apr. 21	Eight. Rep. May 12	Ninth Rep. May 18	Tenth Rep. May 21
1	5	3	0	0	0	0	0	0	0	0
2	3	3	2	1	0	1	0	0	0	0
3	5	2	1	0	0	0	0	0	0	0
4	2	0	0	1	0	0	0	0	0	0
5	6	4	3	2	0	0	1	0	0	0
6	7	2	5	3	1	0	0	0	0	0
7	8	4	3	0	0	2	1	0	0	0
8	4	1	2	0	1	0	0	0	1	0
9	5	3	0	0	0	0	0	0	0	0
10	3	2	0	0	0	0	0	0	0	0
11	5	3	0	1	0	0	1	0	0	0
12	3	5	2	1-3	0	0	0	0	0	0
13	6	2	0	0	1-3	0	0	0	0	0
14	3	2	0	0	0	0	0	0	0	0
15	5	4	0	1	0	0	1-3	0	0	0
16	1	0	0	0	0	0	0	0	0	0
17	4	2	0	1	0	0	0	0	0	0
18	7	..	4	2	2	0	1	0	0	0
19	2	0	0	1	0	0	0	0	0	0
20	4	3	2	1	0	1	0	0	1	0
21	6	2	0	0	0	0	0	0	0	0
22	5	..	2	1	1	0	0	0	0	0
23	3	0	0	0	. 0	0	0	0	0	0
24	5	4	1	0	0	0	0	1	0	0
25	6	1	0	0	0	1	0	0	2-3	0
26	7	2	0	0	1-3	0	0	0	0	0
27	4	4	4	3	1	0	0	1	0	0
28	9	7	6	4	2	0	2	1	0	0
29	7	5	3	0	1	0	0	0	0	0
30	6	1-3	3	0	1	0	0	0	0	0
31	14	12	7	..	4	3	0	0	0	0
32	7	4	2	0	5	1	0	0	0	1
33	6	3	0	0	0	0	0	0	0	0
34	12	4	3	0	0	2	0	1	0	0
35	3	4	2	1	0	1	0	0	0	0
36	7	2	2	0	1	0	0	0	1	0
37	6	4	1-3	0	2	0	0	0	0	0
38	1	0	0	0	0	0	0	0	0	0
39	3	0	1	0	0	0	0	0	0	0
40	1	0	0	1	0	0	0	0	0	0

Results with Sixth Grade

Pupil's No.	First Rep. Mar. 25	Sec. Rep. Mar. 27	Third Rep. Mar. 30	Fourth Rep. Apr 14	Fifth Rep. Apr. 22	Sixth Rep. Apr. 24	Sev. Rep. Apr. 30	Eight. Rep. May 11	Ninth Rep. May 20	Tenth Rep. May 21
1	4	3	2	1	0	0	0	0	0	0
2	3	4	0	1	1	1	0	0	0	0
3	3	1	0	3	3	2	0	0	0	0
4	7	5	0	4	2	0	0	1	0	0
5	4	3	2	0	0	0	0	0	0	0
6	6	2	3	0	2	0	0	1	0	0
7	6	3	2	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	5	2	1	0	2	0	0	0	0	0
10	8	4	4	1	2	1	0	..	0	0
11	5	5	3	3	2	0	2	0	0	0
12	3	2	1	1	1	0	0	0	1	0
13	5	4	3	0	0	1	0	0	..	0
14	6	3	2	1	..	0	0	0	1	0
15	2	1	0	0	0	0	0	0	0	0
16	4	2	0	0	0	4	0	1	0	0
17	8	5	3	2	0	1	0	0	0	0
18	5	3	1	0	0	0	0	0	0	0
19	0	2	3	0	0	0	0	0	0	0
20	3	0	1	0	0	0	0	0	0	0
21	6	3	2	1	1	0	0	1	0	0
22	2	1	0	0	0	0	0	0	0	0
23	4	2	1	0	0	0	0	0	0	0
24	8	5	3	2	1	1	0	1	1	0
25	5	3	1	1	0	0	0	0	0	0
26	3	2	0	0	0	0	0	0	0	0
27	3	0	0	0	0	0	0	0	0	0
28	5	4	..	4	3	2	1	0	0	0
29	6	5	4	3	2	..	..	..	..	..
30	10	7	6	4	2	1	0	1	0	0
31	3	4	8	4	1	2	0	0	1	0

Results with Seventh Grade

Pupil's No.	First Rep. Apr. 20	Sec. Rep. Apr. 21	Third Rep. Apr. 22	Fourth Rep. Apr.23	Fifth Rep. Apr. 24	Sixth Rep. May 1	Sev. Rep. May 8	Eight. Rep. May 22
1	7	3	0	0	0	0	0	0
2	5	4	2	0	0	0	0	0
3	4	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	5	3	0	1	0	0	0	0
6	5	5	4	2	0	2	1	1
7	14	6	5	3	0	1	0	2
8	3	0	2	1	0	0	0	0
9	5	4	3	0	0	0	1	0
10	3	0	2	1	0	0	0	0
11	4	0	2	0	0	0	0	0
12	2	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0
14	7	4	3	0	0	1	0	0
15	16	13	7	4	0	2	1	..
16	16	0	4	2	0	2	0	0
17	13	5	2	0	0	..	0	0
18	4	2	0	0	0	0	0	0
19	18	12	5	1	0	3	2	1
20	3	0	0	0	0	0	0	0
21	5	2	0	0	0	0	1	0
22	8	3	0	1	0	1-3	0	0
23	5	0	2	0	0	2	0	0
24	6	4	3	0	0	0	1	0
25	8	6	4	3	0	0	0	0
26	3	1	0	0	0	0	0	0
27	1	0	0	0	0	0	0	0
28	9	4	3	2	0	0	3	0
29	13	7	4	2	0	2	3	0
30	4	0	2	1	0	0	0	0

Results with Eighth Grade

Pupil's No.	First Rep. Mar. 17	Sec. Rep. Mar. 18	Third Rep. Mar. 25	Fourth Rep. Apr 1	Fifth Rep. Apr. 8	Sixth Rep. Apr. 15	Sev. Rep. Apr. 20	Eighth. Rep. May 15
1	2	1	0	0	0	0	0	0
2	2	1	0	0	0	0	0	0
3	4	1	2	1	0	0	0	0
4	1	0	0	0	0	0	0	0
5	5	3	2	1	0	..	0	0
6	2	0	0	0	0	0	0	0
7	3	1	2	1	0	0	0	0
8	1	2	1	0	0	0	0	0
9	1	0	0	0	0	0	0	0
10	2	0	0	0	0	0	0	0
11	3	2	0	0	0	0	0	0
12	1	0	0	0	0	0	0	0
13	6	4	3	0	0	0	0	0
14	1	0	0	0	0	0	0	0
15	4	2	..	0	0	0	0	0
16	2	1	0	0	0	0	0	0
17	1	0	0	0	0	0	0	0
18	3	2	2	0	0	0	0	0

THE SECOND EXPERIMENT.

The facts which are asked for in the following questions are the ones that were used in the experiment to determine the number of repetitions that would be necessary to fix them with maximum certainty:

1. What is the area of your county? About 400 square miles.

2. Where was it first settled? At Lehighton.

3. What five persons are conspicuously connected with its settlement? White, Hazard, Hauto, Hillegas and Cist.

4. What nickname was applied to Robert E. Lee's father? Light Horse Harry.

5. How many feet above sea level is the highest point of your county? 1735 feet.

6. What is the meaning of the Indian name Towamensing? Wilderness.

7. What five persons are connected with the walking purchase? Edward Marshall, James Yeats, Solomon Jennings, John Penn and Tom Penn.

8. What was the most important sentence uttered by Patrick Henry in the Congress at Philadelphia which he attended? "I am not Virginian, but an American."

9. What was the value of the most important commercial product produced in your locality in 1907? Coal, $9,000,000.

10. What is commercially the most important river in the world? The Chicago.

11. Name the five largest cities of the United States with their approximate population. New York, 4 millions; Chicago, 2 millions; Philadelphia, 1 million; Boston, 649 thousand; St. Louis, 602 thousand.

12. What did Paul Revere say to the men who were guarding the house in which Hancock and Adams were sleeping? "Noise! You'll soon hear noise enough, the Regulars are coming."

13. How many men were lost by the British and the Americans at the battle of Lexington? Americans 93, British 273.

14. What five geological strata have their outcrop in your locality? Pottsville Conglomerate, Pocono Sand Stone, Mauch Chunk Red Shale, Coal Measures, Oriskany Sand Stone.

15. Name one of the two important political institutions begun in Virginia in 1619. Slavery or representative government.

16. What did Lincoln say when he heard of the capture of Vicksburg? "The father of waters now rolls unvexed to the sea."

17. About how many men did the United States lose by the Civil War? About 500,000.

18. What is the name that is applied to the plant from which a large part of the coal was formed? Lepidodendron.

19. Name five men from Pennsylvania who signed the Declaration of Independence. Robert Morris, Benjamin Franklin, Benjamin Rush, James Wilson, James Smith, George Ross, George Taylor and Morton Clymer.

20. What were the last words of Stonewall Jackson? "Let us cross over the river and lie down under the shade of the trees."

In the light of the results obtained in the experiment of the year before, it seemed advisable to continue the work of this year along the same general line, but under somewhat different conditions. Whereas, in the previous experiment all known available means were used to make the first presentation effective in a maximum degree, in this investigation no attempt at emphasis or explanation of any kind was made. The facts to be learned in the second experiment were very much more numerous than in the first, less likely to be easily associated with any facts which the children already knew, and much more likely to contain difficulties of comprehension and understanding. Especially unrelated to anything in the children's experience were the facts called for in question number fourteen. Much of what children are required to learn in school is like Greek to them, and it was deemed advisable by the members of the Seminar to determine how the learning of such facts as to them have probably no meaning or but little meaning, compared with the learning of facts such as are readily associated by them or were made associable by the experimenter. In the first experiment care was taken to select only such facts as seemed essential or would be taught as part of the regular content of the year. In the second investigation an attempt was made to have the facts as heterogeneous as possible and as numerous as could be repeated during one continuous period of mental effort. In the first experiment the facts were relatively few and presented in the most effective manner known, in connection with the regular work of the class in the subject to which they belonged; in the second they are quite heterogeneous, as numerous as possible, almost nonsense syllables in many cases, and presented without instruction or explanation.

The questions numbered 1, 5, 9, 17, require one number for an answer, while 13 requires two. The questions numbered 2, 6, 10 and 18 are answered with one word as also is number 15. Numbers 3 and 7 require the names of five individuals, but number 11 needs for its answer the names of

five cities with which it was supposed that each child included in the test was fairly familiar, and after the names of these cities he was required to write the numbers which represented their approximate population. Three of these numbers he was requested to write by prefixing the figures 4, 2 and 1 before the word million, and the other two of the five numbers required to answer question number 11, it was necessary for him to write 649 and 602 before the word thousands. Question number 14 is answered by five terms all of which were new to the children, rather difficult to spell, and about as difficult to remember for most of the children as nonsense syllables usually are. As an answer for question number 19, the five names of five signers of the Declaration of Independence which were placed first in the list were most frequently written. With at least three of these all of the children in the test were familiar, and it is quite probable that the children had met all of the names at some time during their school careers. Every time that the answer for number 19 was repeated the names of the eight men were repeated, but the children were never required to write more than five.

Question number 4, though grouped with the quotations, is in fact only a nick name of three words and each of these is easily remembered. The answer to questions number 8, 12, 16 and 20, is a short quotation associable with facts with which the children are already fairly familiar, but is the expression of an idea in a form that was entirely new. The general nature of the questions may be readily seen from the following summary:

Numbers 1, 5, 9, 13, 17 are answered by a figure.

Numbers 2, 6, 10, 15, 18 are answered by one word.

Numbers 3, 7, 11, 14, 19 are answered by five words.

Numbers 4, 8, 12, 16, 20 are answered by a quotation.

The directions which were given to the various teachers for conducting the experiment were as follows:

1. The teacher will read the first question.

2. The teacher will read the answer to the first question.

3. The pupils will write the answer to the first question on slips of paper prepared for the purpose.

4. The teacher will read the second question.

5. The teacher will read the answer to the second question.

6. The pupils will write the answer to the second question.

7. The teacher will read the third question.

8. The teacher will read the answer to the third question.

9. The pupil will write the answer to the third question.

10. Thus the teacher will continue to read the questions and then the answers, and the pupils will thus continue to write the answers until all the questions and answers have been

read and all the answers have been written. The papers will then always be sent to the principal.

11. The teacher will then collect the papers on which the answers were written and send them to the principal.

12. At all later repetitions the teacher will read the questions only, but always in the order in which they are numbered. The pupils will write the answer to each question immediately after it has been read.

13. Thus they will continue until the facts are learned; the principal will always fix the date at which a repetition of the facts is to be made.

14. At the close of each repetition, after the papers have been collected the teachers will again read the question and answers in such a way that the reading of each question will be followed by the reading of the answer in regular succession.

The directions were given in this form in the hope of securing uniformity. To have each child write the answer as it was presented to him immediately after the first question was read at the first presentation gave all an equal opportunity to get the impression clearly, and by writing it there was maximum certainty that the impression was received correctly. When the answer that was required had once been definitely fixed, the likelihood was that each following repetition would bring the response required. Oral repetition was practically impossible because of the time it would have required. It was deemed wise to repeat the correct answer to each of the questions immediately after the children had made an attempt to answer them, since it was supposed that each child would listen with close attention for the answers which he was conscious of having missed. Repeating the questions and answers after each repetition had the advantage of making the repetition uniform for each individual of the group, absent ones, however excepted. On the sheets containing the results absentees are indicated by an addition sign.

It is impossible to determine just how faithfully the directions were followed. In the high school the experimenter himself was present at each repetition, and the probability is that the results on the high school sheet represent the honest effort of the group during the time the experiment was in progress according to the directions as given. Just how to account for such phenomenal improvements as a drop from twenty-eight errors to five, or from thirty to one as is indicated in numbers 18 and 19, is rather perplexing. That it may have been possible for these individuals to have made a copy of the answers as they were being repeated by the experimenter, is true, but not likely. Especial vigilance on the part of the three teachers in the room at the time would probably have detected the individuals writing had any of them attempted it. The individuals are apt learners and it is my belief that they simply remem-

bered the facts.

The intervals between the repetitions were by no means uniform. As stated before, the first experiment conducted in connection with work the Pedagogical Seminar had to do with the learning of facts that would ordinarily occur in connection with the regular school work under ordinary normal school conditions as nearly as possible. The second differed from the first in that the facts to be learned were much more numerous and had but little connection with the regular school work, and were presented without any attempt to make the presentation as effective as possible.

In the results that follow, the number of pupils, the number of errors and the date of the repetition is indicated as in the first experiment. The record marked Sixth and Seventh grade was made by a group of chidren in these grades that were taught in the same room by the same teacher. Those marked A Grammar represent the results of the efforts of the eighth grade pupils, while those marked Hauto were made by the grades indicated, all being taught in the same room by one teacher.

The result sheets for the high school and the seventh grade explain themselves, since all the factors recorded are indicated just as on the previous result sheets. The sheet marked Summary of Errors is a tabulation of the errors that were made by the various groups whose record in the second experiment have preceded. The numbers and letters in the left hand column indicate the number and part of the various questions. The numbers in the succeeding columns tell how many errors were made by the groups in answering that particular qrestion whose number is indicated by the figures in the left hand column. The respective groups and the number of pupils that were in each is indicated at the top of each column. The number in the right hand column indicates the number of errors that were made in answering the questions indicated by the entire group. On the sheet marked "Facts Arranged according to Number of Errors" the figure in the first column indicates the number of the question, the number in the second column the entire number of errors that were made with the particular question, and in the third column are the answers desired, or a word describing the answer that was exeepcted to be given.

On averaging the number of repetitions that were re quired to learn the facts by the various individuals the following facts appeared :

Average number of repetitions required by high school pupils 6.

Average number of repetitions required by sixth and seventh grade 7.5.

Average number of repetitions required by seventh grade

7.5.

Average number of repetitions required by A Grammar grade 6.

Average number of repetitions required by Hauto Pupils 6.

The conclusion would, from this, be justifiable that the facts were learned in about seven repetitions.

Pupil	Feb. 9	" 10	" 11	" 12	" 18	" 24	Mar. 8	" 15	" 18	" 19	" 22
1	32	15	5	0	2	4	3	3	0		
2	32	..	..	17	13	11	..	..	4	6	9
3	32	22	23	15	19	18	..	17	13	3	5
4	..	29	17	..	..	18	..	..	..	..	..
5	23	15	8	3	4	6	5	4	4	4	..
6	31	14	8	7	11	..	14	..	11	..	1
7	31	13	6	3							
8	..	13	7	7	5	11	9	3	4	0	
9	17	1	1	0	0	1	0				
10	16	1	0	0	0	0	0				
11	18	2	2	..	4	1	0				
12	18	11	2	0	..	1	1				
13	..	3	0	0	1	0	?				
14	24	0	0	0	0	1	0				
15	19	7	1	0	0	1	0				
16	..	16	7	..	4	..	..	..	..	0	
17	..	20	15	9	11	16	9	8	3	0	
18	28	5	0	0	0	0	0				
19	30	1	0	0	0	0	0				
20	23	0	0	0	..	0	0				
21	18	..	..	2	8	4	2				
22	5	1	0	0	1	1	1				
23	13	8	2	0	0	0	0				
24	27	6	0	1	..	1	0				
25	31	13	5	2	..	..	2				
26	13	..	..	..	0	0	0				
27	31	17	6	1	1	1	0				
28	12	0	0	0	0	0	0				
29	..	15	19	1	3	1	2				
30	31	..	19	4	1	0	0				
31	17	0	0	..	..	4	1				
32	31	..	..	..	..	3	0				
33	29	22	9	0	8	5	4	2			
34	37	28	15	9	4	4	2				
35	..	11	12	..	5	6	6	2			
36	29	16	10	6	4	3	4	1			
37	10	3	..	..	0	4	2				
38	22	1	1	0	0	0	2				
39	24	..	..	..	..	2	..	5	1		
40	34	15	9	2	6	7	5	..	1		
41	29	16	14	9	9	11	4	5	1		
42	..	23	7	..	10	13	3	2			

Pupil	Feb. 9	10	11	12	23	Mar. 8	15	18	19
1	15	15	10	1	..	..	14	7	1
2	13	6	2	8	11	8	..	6	1
3	7	2	..	..	9	..	15	1	
4	2	1	0	0	3	3	0		
5	15	2	0	0	..	5	0		
6	..	34	18	..	13	14	1		
7	22	3	2	..	3	..	0		
8	4	5	0	0	0	0	0		
9	20	7	0	0	2	1			
10	15	5	1	0	0	1			
11	17	8	2	3	2	0			
12	7	1	..	..	6	3	..	2	
13	11	3	0	0	0	0			
14	3	0	0	0	..	2			
15	4	1	0	0	0	0			
16	14	..	2	1	0	1			
17	19	8	..	..	..	..	2		
18	11	9	2	1	3	..	2		
19	20	19	..	7	11	6	1		
20	26	14	5	3	11	5	2		
21	13	1	0	0	0	4	2		
22	9	2	2	0	1	3	0		

HAUTO, 5th   6th   7th

Pupil	Feb. 9	10	11	15	19	24	26	Mar. 9
1	6	10	15	15	8	10	8	2
2	16	9	0	2	0	..		
3	8	10	1	1	..	2	0	
4	8	0	0	1	0	0	0	0
5	22	21	5	9	..	1	0	14
6	21	6	14	8	8	0	0	0
7	9	14	5	0	0	0	1	0
8	7	2	1	2	0	0	0	0
9	4	0	0	0	0	0	1	4
10	7	0	0	1	0	1	0	0
11	15	0	0	1	1	0	0	
12	5	2	0	0	0	0	0	1
13	15	0	0	..	0	0	1	
14	12	8	..	1	0	2	0	0
15	18	17	11	11	5	6	10	5
16	19	9	0	2	0	0	0	1
17	14	10	0	0	2	0		
18	31	20	20	9	..	5	5	
19	18	3	8	1	0	2	0	0
20	24	22	10	16	..	6	5	7
21	8	1	0	..	..	0	0	
22	10	10	6	5	8	6	5	7
23	6	3	0	0	0	0	..	0
24	14	16	11	15	12	10	8	12
25	5	1	0	0	1	0	0	0
26	9	17	1	10	4	1	0	1
27	14	2	3	7	1	0	2	0
28	14	17	0	2	5	3	..	2
29	8	0	0	0	0	0	0	0

Sixth and Seventh Grade

Pupil	Feb. 10	" 11	" 12	" 15	" 17	Mar. 8	" 15	" 16	" 19
1	24	15	7	2	8	7	8	..	0
2	36	15	14	14	7	15	8	11	1
3	18	6	5	3	..	5	9	3	2
4	27	11	7	5	5	18	9	0	
5	12	6	8	6	9	..	5	0	
6	38	27	29	24	29	36	32	33	33
7	32	15	12	10	8	15	12	7	4
8	35	20	9	..	15	12	..	9	
9	31	11	9	6	19	..	10	5	9
10	27	10	7	5	8	13	10	5	..
11	26	11	5	7	..	..	..	..	..
12	24	6	0	0	0	3	0		
13	28	4	6	5	2	3	0		
14	27	..	3	8	7	5	2		
15	26	5	5	3	4	3	2		
16	15	3	2	0	0	..	0		
17	18	1	0	0	0	0	0		
18	14	0	0	0	0	2			
19	14	3	2	0	0	5	1		
20	21	3	5	3	3	2			
21	24	3	3	2	3	2			
22	14	0	0	0	0	2			
23	14	5	1	0	0	1			
24	12	7	4	..	..	..	18	12	0
25	36	26	29	16	20	25	7	..	1
26	22	13	..	..	5	5	10	4	0
27	3	0	1	0	4	0	0	2	
28	25	8	0	2	0	7	3	1	
29	23	7	4	2	2	4	7	2	

Pupil	Feb. 10	" 11	" 12	" 15	" 17	Mar. 8	" 15	" 16	" 18	" 19
1	27	19	15	..	8	13	13	..	10	5
2	27	20	19	20	10	15	18	6	9	4
3	24	..	..	26	2					
4	27	17	12	12	..	15	4	9	3	0
5	27	25	16	21	3	4	10	5	1	
6	28	23	17	20	5	10	9	7	6	1
7	29	20	15	17	9	10	..	..	4	1
8	29	26	22	24	1	..	12	3	..	1
9	34	28	14	17	8	3	1			
10	..	28	19	..	5	12	2			
11	..	..	..	..	..	..	1	0		
12	26	18	8	9	0	10	1			
13	37	30	19	23	7	8	2			
14	..	5	2	1	..	..	1			
15	20	9	7	..	0	0				
16	28	16	18	25	1	0				
17	..	6	7	5	0	1				
18	..	18	14	..	1	7	..	0		
19	24	14	6	10	9	8	1			
20	..	27	24	..	8	19	15	0		
21	27	22	21	20	8	12	4	2		
22	27	18	19	..	4	9	6	0		
23	34	..	24	21	6	8	8	0		
24	25	17	10	11	2	12	7	0		
25	22	11	7	9	0	8	5	0		
26	30	19	15	..	11	11	..	1		
27	28	20	12	13	2	..	12	..	6	2
28	32	20	25	20	6	15	8	1		
29	28	22	15	..	..	6	..	13	0	
30	28	25	14	19	2	9	..	7	0	
31	..	21	11	17	4	6	5	4	1	
32	27	21	14	13	5	15	6	6	2	
33	29	15	9	..	44	6	8	6	0	
34	25	20	18	16	9	16	7	-	2	
35	29	16	15	12	4	11	11	5	0	
36	26	14	13	13	26	12	8	3	0	
37	38	27	26	25	7	20	12	7	1	
38	33	28	19	..	..	16	12	18	2	
39	39	27	18	30	7	13	8	7	2	

Summary of Errors

	High 42 Pu.	B Gr. 39 Pu.	6th. Gr. 39 Pu.	6 & 7 Gr. 29 Pu.	A Gr. 22 Pu.	5, 6 & 7 Gr. 30 Pu.	
1	8	12	8	5	4	1	38
2	14	39	15	4	5	1	78
3a	20	51	6	24	10	4	115
b	38	83	21	29	17	2	190
c	44	108	27	34	11	4	227
d	56	111	40	64	21	6	288
e	59	80	41	66	17	9	272
4	7	11	4	0	0	1	23
5	46	75	13	46	7	6	193
6	14	17	3	11	2	2	49
7a	47	96	55	43	17	13	271
b	57	110	81	51	18	17	334
c	55	128	100	64	32	18	377
d	59	146	82	59	31	20	317
e	60	107	58	57	32	27	341
8	8	21	14	10	16	8	76
9	22	50	42	30	6	44	194
10	5	4	7	12	3	5	36
11a	35	79	52	30	9	13	218
b	63	123	87	42	19	26	360
c	68	133	73	44	23	34	375
d	77	190	136	72	28	43	546
e	98	166	125	72	39	45	545
12	13	11	5	4	5	10	48
13a	33	26	5	13	7	12	96
b	51	47	32	21	33	26	210
14a	43	49	46	16	6	41	201
b	66	91	68	19	16	52	312
c	72	115	65	34	11	62	359
d	85	127	76	52	14	74	428
e	84	108	64	58	22	77	413
15	56	14	42	28	5	12	157
16	32	52	56	30	25	35	230
17	67	122	93	34	26	34	384
18	40	72	63	34	5	10	224
19a	35	90	62	33	21	35	276
b	47	136	87	43	23	40	376
c	60	136	98	68	29	37	398
d	77	157	109	74	40	56	513
e	74	125	82	75	41	59	456
20	15	23	16	12	4	15	95

Facts arranged according to number of errors

4	23	Nickname.
10	36	Chicago.
1	38	One Number.
12	48	One Number.
6	49	Wilderness.
8	76	Quotation.
2	78	Familiar Name.
20	95	Quotation.
13a	96	Number.
3a	115	Packer(town).
15	157	Slavery or Rep. Gov.
3b	190	Hauto(town).
5	193	Number.
9	194	Number.
14a	201	Potts. Cong. (town).
13b	210	Number.
11a	218	City & Number.
18	224	Term (Rhododendron).
13c	227	Hazard (Town).
16	230	Quotation.
7a	271	Marshall (unfamiliar name).
3e	272	Cist (unfamiliar name).
19a	276	Robert Morris.
3d	288	Hillegas (unfamiliar name).
14b	312	Pocono Sandstone.
7b	334	James Yeats (unfamiliar name).
7e	341	Solomon Jennings (unfamiliar name)
14c	359	Mauch Chunk Red Shale.
11b	360	Chicago, 2 mill.
19b	376	Benjamin Rush.
11c	375	Phila., 1 mill.
17	384	500,000.
7d	397	John Penn.
19c	398	Franklin.
7c	399	Solomon Jennings.
14c	413	Oriskany Sandstone.
14d	428	Coal Measurer (familiar).
19e	456	James Smith.
19d	513	Morton Clymer.
11e	545	St. Louis, 649 thous.
11d	546	Boston, 602 thous.

THE THIRD EXPERIMENT.

In the light of the results obtained in the previous experiments, it seemed advisable to try to determine how the learning of forgotten facts compared with the results in former experiments. In order to make this comparison, the following list of questions was selected to be used with the pupils in the high school. All the children now in this school were taught in the A Grammar room by the same teacher. He declares that every pupil who passed through his room at one time knew the facts called for in the questions.

The experiment was conducted by the experimenter in accordance with the directions given for the second experiment, except that there was no first presentation of the facts. It was assumed that each pupil was familiar with the facts and the first exercise of this experiment was conducted just as was the first repetition in the first and second experiment. The interval was arbitrarily fixed at a week, though the results would no doubt have been somewhat better had the interval been shorter. The number of questions was so arranged as to require the writing of about as many facts as were required in the second experiment. This, it was thought would make the matter of comparison somewhat simpler. The questions used follow:

I.   1. How many degrees from the north pole to the equator? 90.

2. In what year was the ordinance passed which related to the government of the Northwest Territory? 1787.

3. In what year was Jamestown settled? 1609

4. When was the Pacific Ocean discovered? 1513.

5. In what year was the Mexican War begun? 1848.

II.   1. In whose administration did the President refuse to sign the Bank Charter? Jackson's.

2. In whose administration was Louisiana purchased? Jefferson's.

3. In whose administration was the Second War with England? Madison's.

4. In what war was the Battle of Long Island fought? Revolutionary.

5. To what party did Thomas Jefferson belong? Anti Federalists.

III.   1. What large island south east of Africa? Madagascar.

2. What ocean south of Hindoostan? Indian.

3. What mountain range between Europe and Asia? Ural.

4. What river between the United States and Canada? St. Lawrence.

5. What cape at the southern extermity of South America? Cape Horn.

IV. 1. By whom was South America discovered? Columbus.

    2. Who probably was the originator of the Monroe Doctrine? J. Q. Adams.

    3. By what title is the ruler of Turkey known? Sultan.

    4. How many years did Washington serve as President? Eight.

    5. What leader crushed the Creeks and Seminoles in Florida? Jackson.

V. 1. Name in their order five rebellions that have occurred in our history. (a) Claybourne's, (b) Bacon's, (c) Whiskey, (d) Dorr, (e) Great Rebellion.

VI. For what achievement are the following men noted?

    1. Thomas A. Edison.

    2. S. F. B. Morse.

    3. Geo. B. Meade.

    4. Eli Whitney.

    5. Elias Howe.

VII. Beginning with Florida name five States in succession that border on the Atlantic Ocean, Florida, Georgia, South Carolina, North Carolina and Virginia.

VIII. 1. What is the capital of Germany? Berlin.

    2. What is the capital of Cuba? Havana.

    3. In what country is Sydney located? New South Wales.

    4. In what country is Buenos Ayres located? Argentine Republic.

    5. In what country is Venice located? Italy.

IX. State briefly the substance of the Monroe Doctrine.

    For any European country to try to gain dominion in America will be considered an unfriendly act by the United States.

Of the forty-one possible errors the best record was made by a boy who wrote all of the answers correctly except seven, and the poorest record was made by a girl who missed thirty-six. No one was more surprised than the experimenter to learn that so many of the facts once well known and quite familiar should so soon be forgotten. The teacher who taught the pupils while they were in the Grammar School was equally surprised.

Thirty of the individuals in the test learned to write the forty-one facts by having two repetitions; the remaining thirteen required three. The ease and readiness with which they were recalled is perhaps as surprising as the fact that so large a part of the educational content, which was considered well taught and well known, should have been so easily forgotten.

In the results which follow, the numbers in the first column denote the number of pupils and the other numbers indicate the errors made in the various repetitions. With the pupils after whose number there is nothing in the third column the facts were learned in two repetitions.

Fifth Grade   Facts of Experiment I

Pupils	Jan. 28	Jan. 31	Mar. 1	Mar. 31
1	8	4 1-3	0	0
2	7 1-3	11	6 1-3	0
3	12 1-3	3 2-3	4	1
4	17	7	5	3 2-3
5	8 2-3	5 1-2	0	1
6	6 2-3	1	1	2
7	9 1-3	4	1	2
8	8 2-3	1	0	0
9	8 1-3	0	0	0
10	10 1-3	2	0	0
11	8 2-3	0	0	0
12	6 2-3	0	1-2	0
13	13 1-2	2 2-3	4	5
14	12 1-2	2	1	0
15	6 5-6	1	0	0
16	12 1-3	0	1	1
17	14 1-2	0	4 1-3	3
18	13 1-3	0	1	1
19	12	5	2-3	2
20	12 1-3	6	7	6
21	6 1-3	0	2	0
22	14 2-3	1	2 1-3	0
23	9 1-2	0	3	0
24	20	7	7	4 1-3
25	13 1-3	0	1	..
26	8	0	0	1-3
27	19	9 1-3	11	10 2-3
28	14 2-3	0	8 1-3	3
29	16	1	3	1
30	13 1-3	6	5	1
31	17 2-3	8	12	6 1-3
32	6 2-3	0	1	2
33	15	0	1	0
34	16	2 1-3	4	3
35	17	0	1-2	4
	416 1-2	90 5-6	98	63 1-3

31
Results of Repetition of Facts Used in Third Experiment

No. of Pupils	Nov. 24	Jan. 27	Mar. 21
1	12	10	4
2	11	10	13
3	4	9	..
4	13	6	1
5	9	7	0
6	5	5	1
7	15	..	..
8	13	1	0
9	20	13	..
10	10	4	1
11	11	5	2
12	5	7	1
13	13	6	18
14	7	6	2
15	4	2	1
16	8	10	9
17	4	2	0
18	15	7	2
19	14	14	17
20	16	11	12
21	5	4	0
22	9	4	5
23	10	13	12
24	10	1	2
25	7	1	0
26	10	12	4
27	10	11	13
28	9	4	..
29	13	1	6
30	9	7	..
31	5	7	5
32	8	1	1
33	5	4	0
34	9	3	5
35	9	8	11
36	15	15	..
37	8	14	8
38	3	0	0
39	8	7	..
40	..	20	12
41	14	12	11
42	12	..	18
	397	284	197

THE FOURTH EXPERIMENT.

In order to determine the interval at which facts once well known should be repeated in order that they may not be forgotten, it seemed expedient to use the facts that had been learned in the previous experiments. The facts used in the second were at one time known to the children, and the experimenter had positive knowledge of the conditions under which they were learned. It was therefore arranged to call for a repetition of these facts at varying intervals.

The results of these repetitions follow. They are headed respectively: Results with High School, Results with A Grammar School, and Results with Seventh Grade, A and B Divisions.

Since the facts of the second experiment were rather difficult to learn, and since the conditions under which they would be forgotten would probably differ somewhat from the manner of forgetting things learned under ordinary school conditions, it was decided that in this attempt at determining the length of the interval, it would be well to use also the facts of the third experiment which were regularly learned as school lessons as well as the facts used with the fifth grade in the first experiment. The fifth grade had, with seeming ease, learned the facts presented to them in what seemed to be a remarkably short time and there existed an interval of twenty months since the last repetition.

The results of the last mentioned repetitions will also be found on the following sheets: The sheet containing the results obtained with facts of experiment three are so designated, and the results obtained with what were fifth grade pupils when the facts were given in the first experiment, are headed Fifth Grade of 1907, Experiment 1; though it must not be forgotten that these pupils are now seventh grade children, and that in the meanwhile they have not studied the Geography of South America as a regular school lesson.

The sheet containing a summarization of the results has the summary of the results obtained with each group, similarly designated.

A glance at the Summary of Results will show the fact that the accuracy of the average of errors is dependent upon the children who were absent. If the absentees were individuals who usually had more than the average number of errors, the general average was proportionately lowered, and if the absentees were those who usually made less than the average number of errors, this general average was increased, since their absence would diminish the divisor by one and have but little effect upon the dividend. Since, however, in no case the absence of any child affected the general average more than 1, it was considered by the members of the Seminar that this cause of variation might be regarded as a negligible factor.

It will be observed that with the High School, A Grammar and Seventh Grades the interval and the average of errors is comparatively uniform in the first repetition, and that the reduction of the average of errors on the part of the high school pupils furnishes an exception in the second. The one day interval caused reduction in the average of errors of more than ten in each case. A reduction of 1.3 in the average of errors is the least reduction that was caused by the thirteen day interval; but that there was a reduction in each case is an indication that this interval is too short.

The twenty-eight day interval caused a reduction with the high school and Seventh Grade, B. Division, but a considerable increase in A Grammar. The A Grammar furnishes another exception in that it indicates a reduction in the average of errors when the interval is nearly twice as long. This would indicate that the increase of the average in the former repetition was probably due to some disturbing factor and the conclusion could still be drawn that an interval of a month is not too long.

In the Seventh Grade, A Division, the interval was made seventy-four days and the average of errors is nearly doubled. In the Seventh Grade, B Division, an interval of thirty-nine days and of forty days caused a reduction. Thirty day interval which was fixed between the last repetition caused considerable reduction in each case except with the Seventh Grade, B Division, where it remained the same.

It will be noticed that the reduction in each case in the last repetition is quite considerable except in the case of the Seventh Grade, B Division, where there is no change. It will also be seen that there is a reduction in every case where the interval was less than fifty days except in the forty-nine day interval with the high school.

• Though it by no means follows as an undeniable conclusion, the inference at least seems justifiable, that with a repetition interval of about sixty days, the average of error will remain fairly constant. In consideration of the rapid decreases in the last repetitions, the experimenter feels free to believe that this interval could be increased in arithmetical ratio, in which five days would represent the common difference of the varying intervals.

In the opinion of the experimenter, the inference and the belief above stated are confirmed by the results summarized under, Fifth Grade of 1907 and Facts of Experiment Three, even though the twenty-eight day interval would seem to be an exception.

Results with High School

No. of Pupils	Nov. 1	Nov. 2	Nov. 15	Dec. 13	Jan. 31	Mar. 2	Apr. 1
1	21	0	0	1	3	0	0
2	8	2	6	4	11	6	0
3	19	3	0	0	2	0	0
4	23	0	0	3	9	0	0
5	26	4	..	3	10	2	0
6	28	8	4	5	14	8	8
7	..	2	0	2	0	0	..
8	31	16	5	7	7	3	3
9	21	6	2	1	1	..	0
10	32	7	6	3	3	2	0
11	12	0	0	0	0	2	0
12	10	0	0	0	0	..	0
13	18	13	..	13	7	..	2
14	28	15	8	15	15	9	3
15	12	1	0	0	0	0	0
16	29	0	0	1	0	1	0
17	12	1	0	4	2	2	0
18	22	..	..	2	2	0	0
19	16	5	3	5	2	0	4
20	25	2	1	1	1	0	0
21	4	4	0	1	0	0	0
22	39	9	4	7	8	7	3
23	21	..	5	7	8	7	1
24	30	5	1	2	1	0	0
25	22	4	..	0	5		..
26	17	2	2	4	5	3	..
27	23	5	3	3	4	1	4
28	14	0	0	0	0	0	0
29	23	0	..	0	0	0	1
30	30	3	3	2	0	0	0
31	15	0	2	1	0	0	0
32	22	0	2	0	0	0	0
33	22	11	6	4	0	0	2
34	13	0	0	0	0	2	..
35	22	..	0	1	0	0	0
36	4	0	0	2	0	0	0
37	32	8	8	..	11	3	..
38	11	0	0	0	0	0	0
39	9	0	0	1	1	0	0
40	13	0	0	0	0	3	1
41	9	0	1	0	0	0	1
42	31	10	5	5	13	5	0
43	4	6	0	0	0	0	0
44	26	1	1	..	..	12	3
45	27	5	..	3	..	1	0
46	27	4	0	0	0	2	6
47	27	10	5	..	..	8	..
	930	172	83	113	145	89	36

Results with A Grammar

No. of Pupils	Nov. 1	Nov. 2	Nov. 15	Dec. 13	Jan. 31	Mar. 2	Mar. 31
1	27	8	3	4	7	4	4
2	34	18	10	10	4	8	4
3	28	12	6	..	..	..	..
4	23	5	2	..	4	3	4
5	23	10	10	11	11	..	8
6	23	..	17	11	16	23	..
7	24	11	5	12	8	3	2
8	28	17	11	7	11	..	3
9	31	18	16	16	7	13	..
10	9	1	..	..	5	1	0
11	31	9	6	4	7	4	3
12	19	..	6	1	1	0	0
13	22	..	..	19	22	20	12
14	23	11	10	..	9	..	..
15	32	20	15	17	13	7	8
16	22	4	2	..	3	..	5
17	20	16	13	14	9	9	2
18	35	23	17	15	15	15	13
19	24	16	11	4	1	..	4
20	25	17	15	16	16	15	6
21	..	..	21	18	15	10	9
22	23	7	0	5	2	0	2
23	16	3	1	1	1	0	0
24	20	6	..	4	1	0	2
25	30	18	5	12	10	11	10
26	29	16	8	17	16	13	12
27	16	11	4	9	7	4	3
28	28	9	3	3	6	2	0
29	32	18	17	16	17	..	17
30	29	19	12	12	11	..	..
31	28	11	3	13	12	9	5
32	21	19	4	13	2	5	13
33	20	6	8	5	3	6	0
34	22	8	8	5	6	7	..
35	18	6	3	2	1	0	2
36	20	6	6	13	6	..	..
37	29	12	12	8	9	2	3
	884	301	290	317	294	194	156

Results with Seventh Grade

Seventh Grade - B Division								Seventh Grade - A Division						
No. of Pupils	Nov. 1	Nov. 2	Nov. 15	Dec. 13	Jan. 21	Mar. 2	Mar. 31	No. of Pupils	Nov. 1	Nov. 2	Nov. 15	Jan. 28	Mar. 2	Apr. 1
1	30	16	12	11	7	9	5	1	23	8	0	3	0	0
2	23	6	5	1	2	..	1	2	17	3	0	0	0	..
3	..	15	9	17	14	13	9	3	37	16	15	21	23	15
4	26	10	14	10	7	1	5	4	31	11	2	..	3	7
5	7	0	6	4	1	1	0	5	23	10	0	3	..	2
6	16	9	10	7	8	5	5	6	26	18	6	12	8	7
7	19	3	2	0	2	3	0	7	29	7	3	..	12	6
8	16	8	8	10	2	3	4	8	17	6	7	10	..	3
9	10	1	1	0	0	1	0	9	26	17	8	21	19	19
10	24	8	6	4	5	0	4	10	34	20	..	16	11	23
11	11	5	0	1	0	0	0	11	26	7	9	10	12	4
12	25	6	6	1	1	1	3	12	29	10	0	0	4	6
13	28	11	13	8	8	6	3	13	22	9	..	9	1	0
14	17	9	0	11	10	4	8	14	20	16	15	13	0	0
15	17	10	11	2	9	..	0	15	19	6	10	7	5	8
16	24	7	5	3	4	4	3	16	31	18	14	26	22	18
17	36	14	15	7	4	16	9	17	20	7	0	3	0	0
18	19	4	5	4	3	3	..	18	22	15	8	6	9	2
19	26	19	..	22	20	5	14	19	18	8	3	10	1	0
20	23	5	5	2	2	0	..	20	11	..	0	1	0	1
21	20	6	5	4	4	0	1	21	16	6	3	..	0	0
22	30	18	16	12	12	2	3	22	23	10	2	0	9	0
	448	190	154	141	125	77	77	23	23	7	9	2	10	6
								24	25	0	5	15	..	..
								25	26	6	8	18	11	17
									594	241	127	206	160	144

No. of Repetitions	No. of Children	Total Number of Errors	Average of Errors	Length of Interval
High School				
1	46	930	20.2	224 days
2	44	172	3.9	1 day
3	41	83	2.02	13 days
4	44	113	2.5	28 days
5	44	145	3.3	49 days
6	43	89	2.07	30 days
7	41	36	.88	30 days
A Grammar				
1	36	884	24.5	227 days
2	33	391	11.8	1 day
3	34	290	8.5	13 days
4	32	317	9.9	28 days
5	36	294	8.16	49 days
6	26	194	7.46	30 days
7	30	156	5.2	29 days
Seventh Grade- A Division				
1	25	594	23.7	237 days
2	24	241	10.04	1 day
3	23	127	5.5	13 days
4	22	206	9.36	74 days
5	22	160	7.27	33 days
6	23	144	6.26	30 days
Seventh Grade- B Division				
1	21	448	21.3	237 days
2	22	190	8.6	1 day
3	21	154	7.3	13 days
4	22	141	6.4	28 days
5	22	125	5.68	39 days
6	20	77	3.8	40 days
7	20	77	3.8	29 days
Fifth Grade of 1907				
Facts of First Experiment				
1	35	416.5	11.9	20 mos.
2	35	90.83	2.59	2 days
3	35	98	2.8	28 days
4	34	63.3	1.8	30 days
Results with Facts of				
Experiment Three				
1	41	397	9.7	9.5 mos.
2	40	284	6.5	64 days
3	38	197	5.2	53 days